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Carlos Bates' Dwarf Mistletoe Resistant Ponderosa Pines: A Postscript After Half a Century[1]

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Progeny of ponderosa pines (*Pinus ponderosa* var. *scopulorum*) presumably resistant to dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum*) were planted in Colorado in 1932. When the trees were examined in 1979, no difference was found in mistletoe susceptibility between supposedly resistant trees and trees thought to be susceptible. The study is of historical significance as it is one of the first attempts to breed forest trees for resistance to disease in North America.

Keywords: Dwarf mistletoe, *Arceuthobium*, resistance

Introduction

Resistance to dwarf mistletoes was first reported by J. Roeser (1926) and Carlos Bates (1927). They discovered some ponderosa pines (*Pinus ponderosa* var. *scopulorum* Engelm.) that apparently were resistant to *Arceuthobium vaginatum* subsp. *cryptopodum* (Engelm.) Hawksw. & Wiens, at the Fremont Forest Experiment Station west of Colorado Springs, Colo. Although the reason for the presumed resistance was not determined, they noted that these trees were slower growing and "lacked succulence in the twigs" (Bates 1927). Less vigorous trees are generally more resistant to dwarf mistletoes (Hawksworth 1961). Bates' controlled crossings of these parent trees to develop resistant progeny is of historical significance as it represents one of the earliest (if not the first) attempts at breeding for disease resistance in forest trees in North America.

[1]*Jacob Roeser, Jr. (now deceased), who made the plantings, provided information on the study and accompanied the senior author on a visit to the plots in 1959.*

[2]*Forest Pathologist and Mensurationist, respectively. Rocky Mountain Forest and Range Experiment Station; headquarters is in Fort Collins, in cooperation with Colorado State University.*

No results of the plantings have been published, and the Fremont Forest Experiment Station was abandoned in 1935. However, Fuhlrodt (1967), in his history of the Experiment Station, briefly discusses the mistletoe resistance plantings and presents a 1950 photograph of the plots. This article summarizes the plantings based on an examination in 1979 (figs. 1, 2).

Little is known even now of the genetic resistance of conifers to dwarf mistletoes, but resistance has been observed in ponderosa pine in the Southwest (Hawksworth 1961) and in the Pacific Northwest (Roth 1978).

Materials and Methods

Two outplantings of putatively resistant (2-0) ponderosa pine seedlings were made on the Fremont Forest Experiment Station in 1932 by Jacob Roeser, Jr., a coworker of Carlos Bates. The plantings were made on an approximately 25% south slope at about 9,000 feet (2,750 m) in the ponderosa pine zone. Progeny of "resistant" strain trees were planted, along with presumably nonresistant and "doubtful" strains, on the two plots.

Figure 1.—Plot C-14 from the west, 1979.

Figure 2.—Sign marking plot C-14, installed by the Pike National Forest.

Details of the pollination techniques used are not available. However, unpublished reports on the study state that the "cone-flowers were carefully pollinated." Presumably, conelets were bagged to exclude foreign pollen.

Plot C-14

This plot was 120 by 160 feet (36.6 by 48.8 m) and contained 1,290 seedlings planted at 4-foot (1.2-m) square spacings. Seedlings of three types—"resistant," "nonresistant," and "doubtful"—were planted in random rows of 10 seedlings each, throughout the plot. In addition, a boundary row of resistant areas was planted around the plot. Some heavily infected older ponderosa pine were left adjacent to the north half of the plot to provide a mistletoe seed source to determine relative susceptibility of the seedlings.

Since mistletoe-infected trees were adjacent to the northern half of the plot, only that portion was re-examined in 1979 (fig. 3). For each living tree, the total height, diameter at breast height, and dwarf mistletoe rating (6-class system, Hawksworth 1977) were recorded.

Plot C-13-26

This plot was 56 by 80 feet (17.1 by 24.4 m) and contained 280 seedlings from the same seed sources used for plot C-14. This plot was apparently planned for use in artificial mistletoe inoculations, as no infected trees were left adjacent to the plot. The inoculations were not made, so no data on the relative susceptibility were obtained from the plot. Only survival data were obtained in 1979.

Results

Of the trees outplanted in 1932, 57% were mistletoe-infected in 1979, and their average mistletoe rating was 1.8 (table 1). There were no significant differences among percentages of trees infected or in average mistletoe ratings in trees of the three susceptibility classes. In 1979, 69% of the trees planted in plot C-14 and 44% of those in plot C-13-26 were alive. The survival rates were not significantly different for trees that were thought to be mistletoe-resistant, those thought to be susceptible, and those of doubtful status (table 1).

The results show little effect of dwarf mistletoe infection on tree height or diameter (table 2). Although trees in class 6 appear to be somewhat smaller, no statistical significance can be demonstrated because of the low number of trees in this class. In other studies with this mistletoe, growth rates of class 5 or 6 trees were significantly reduced (Hawksworth 1961). Possibly the very

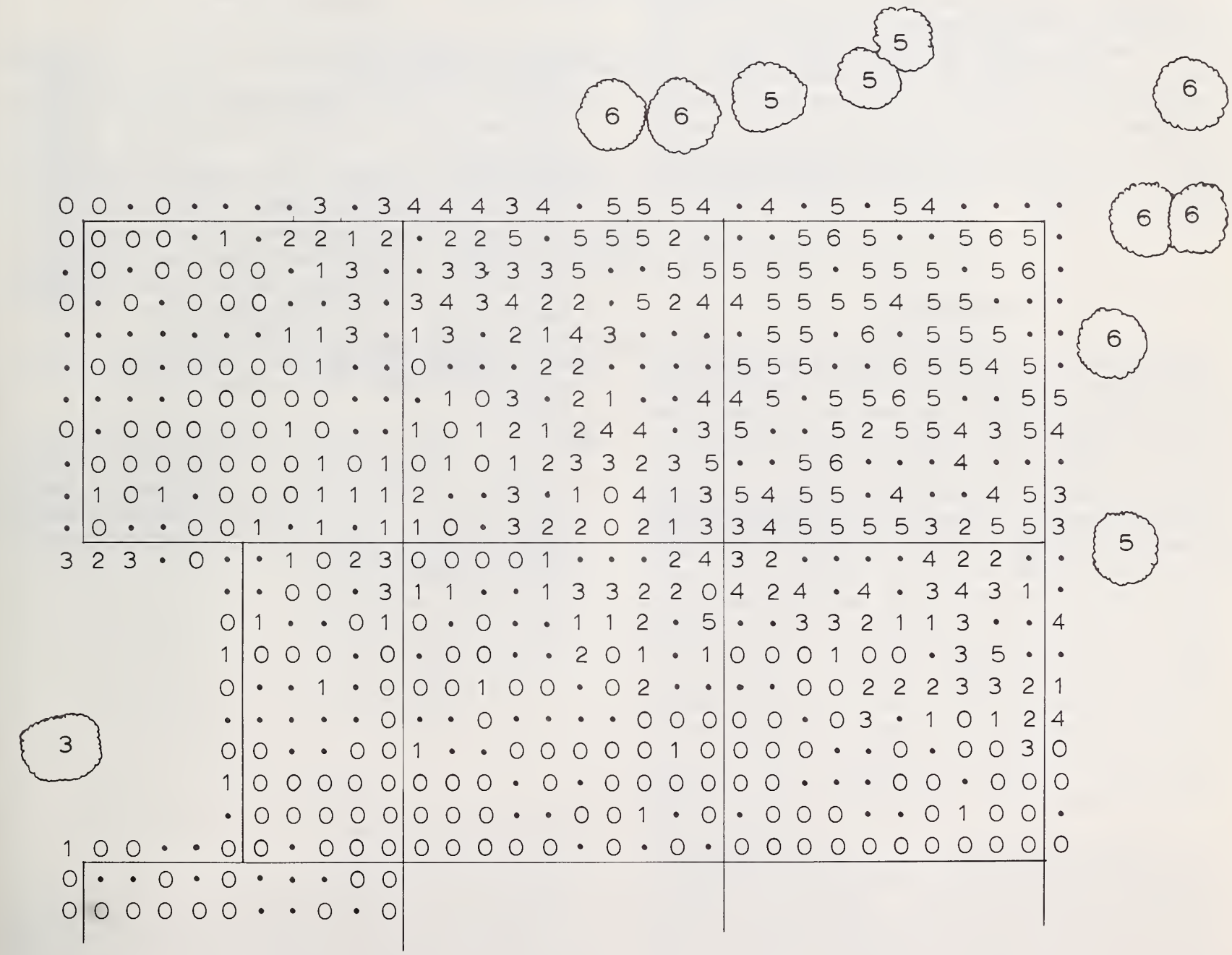

Figure 3.—The north half of plot C-14. The squares indicate 40-by 40-foot subplots. Ten seedlings of each seed source were planted in horizontal rows. The status of each tree in 1979 is shown: a black dot indicates a tree dead or missing; the numbers show the 0 to 6 mistletoe rating of each live tree. The 11 infected residual trees which provided the sources of infection in the plantation are shown. (The number indicates the mistletoe rating of each tree.)

Table 1.—Status in 1979 of trees planted in the north half of plot C-14 in 1932 (including boundary row)

Seedling type	Trees planted in 1932	Status in 1979		
		Trees live	Trees mistletoe-infected	Average mistletoe rating
	number	*percent*		
Resistant	408	68	56	1.9
Doubtful	124	80	62	1.8
Susceptible	91	60	55	1.4
Combined	623	69	57	1.8

Table 2.—Heights (feet) and diameters (inches) of trees in plot C-14 in relation to dwarf mistletoe rating[1]

Dwarf mistletoe rating	Trees	Height	Diameter
	number	*mean ± SD*	
0	167	15.5 ± 3.0	3.17 ± 0.91
1	53	15.8 ± 2.9	3.28 ± 0.89
2	43	13.7 ± 3.3	2.62 ± 0.90
3	44	15.5 ± 3.4	3.41 ± 0.83
4	34	12.9 ± 2.9	2.94 ± 0.83
5	66	13.4 ± 2.3	3.27 ± 0.82
6	7	11.4 ± 2.9	2.46 ± 0.93

[1]*Combined data for all three seedling types, including trees planted around boundary of plot.*

dense planting at Fremont (over 2,700 trees per acre) may have masked some dwarf mistletoe effects. Also, the very dense planting presumably suppressed height and diameter growth of these trees. The maximum distance of a young, infected tree from a source tree outside the plot was 68 feet (20.7 m). This indicates a rate of dwarf mistletoe spread of 1.4 feet (0.4 m) per year, which is comparable to estimates based on stand reconstruction data (Hawksworth 1961).

Discussion

Although the presumed dwarf mistletoe resistance was apparently not transmitted to the progeny, this study is of considerable historical interest because it represents one of the first attempts to breed forest trees for resistance to disease. According to reports on file at the Rocky Mountain Forest and Range Experiment Station, the first crosses of presumably resistant trees were made in 1926, although preliminary screening of resistant trees was done as early as 1924.

Literature Cited

Bates, C. G. 1927. Better seeds, better trees. Journal of Forestry 25:130-144.

Fuhlrodt, V. C. 1967. A history of the Fremont Forest Experiment Station, Widefield High School, Security, Colo. 147 p.

Hawksworth, F. G. 1961. Dwarf mistletoe of ponderosa pine in the Southwest. Technical Bulletin 1246. 112 p. U.S. Department of Agriculture, Washington, D.C.

Hawksworth, F. G. 1977. The 6-class dwarf mistletoe rating system. USDA Forest Service General Technical Report RM-48. 7 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Roeser, J. 1926. The importance of seed source and the possibilities of forest tree breeding. Journal of Forestry 24:38-51.

Roth, L. F. 1978. Genetic control of dwarf mistletoe. p. 69-72. In proceedings of the symposium on dwarf mistletoe control through forest management. USDA Forest Service General Technical Report PSW-31. 190 p. Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.

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